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RESPONSE OF 40 AND OVER AGED MILITARY PERSONNEL TO AN UNSUPERVI--ETC(U)
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20. ABSTRACT

of exercise. The mean $\pm$ SD for $\dot{V}O_2max$ and %BF for all subjects was 38.1 $\pm$ 6.2 ml/kg·min and 26.1 $\pm$ 4.7%, respectively. Subjects were divided into three groups based upon their initial level of physical activity determined by interview as follows: inactive, moderately active and active. Upon retesting after 6 months, 40% of the inactive group had not participated to any appreciable degree in the program and subjects of this group who did participate showed only a slight and insignificant increase (4.4%) in $\dot{V}O_2max$. The pretraining level of $\dot{V}O_2max$ for the total population studied was similar to that reported in other studies on comparably aged subjects. However, changes with training were well below those seen with supervised group programs of 6 months duration.

Response of 40 and Over Aged Military Personnel

to an Unsupervised, Self-Administered Aerobic Training Program

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Abstract

The Army recently extended mandatory physical training and testing to include personnel 40 yrs of age and older. The purpose of this study was to describe the profile of aerobic fitness in a representative group from this age population and to evaluate the response of such a group to a self-administered, unsupervised training program. Maximal oxygen uptake ($\dot{V}O_2$ max) and percent body fat (%BF) were assessed in 295 military personnel (40-53 yrs of age) before and after 6-months of physical training consisting of a progressive walk/run mode of exercise. The mean $\pm$ SD for $\dot{V}O_2$ max and %BF for all subjects was 38.1 $\pm$ 6.2 ml/kg • min and 26.1 $\pm$ 4.7%, respectively. Subjects were divided into three groups based upon their initial level of physical activity determined by interview as follows: inactive, moderately active and active. Upon retesting after 6 months, 40% of the inactive group had not participated to any appreciable degree in the program and subjects of this group who did participate showed only a slight and insignificant increase (4.4%) in $\dot{V}O_2$ max. The pre-training level of $\dot{V}O_2$ max for the total population studied was similar to that reported in other studies on comparably aged subjects. However, changes with training were well below those seen with supervised group programs of 6 months duration.

Indexing words: aerobic power, physical training, 40 and over aged personnel

The past few years has seen considerable attention given to the quantification of various aerobic training programs (6,24,25) and to the assessment of aerobic fitness (4,25,36) in young (less than 35 years of age), military populations. On the other hand, aerobic training/fitness has been largely ignored for the over 40 year old age group in the military. Until very recently such personnel, for the most part, did not have a specific fitness program and were not required to meet any minimum fitness standard.

The need to overcome the sedentary lifestyle of the adult population has been recognized for sometime. Physical inactivity has been intimately associated with obesity and premature cardiovascular disease (11). By age alone, the individual who is 40 years of age or older is already at an increased risk for the development of coronary artery disease which may, in part, be attributed to a lack of physical activity. It has also been suggested that physical activity associated with an increase in aerobic power imparts improved morale, sense of well-being, general health, and sedentary job performance (31). While these benefits are obviously desirable for all individuals, they are of particular importance to military personnel who, regardless of age, have the unique job potential of being mobilized at any time to respond to a national emergency which could entail considerable physical and mental stress.

The Chief of Staff, US Army, recently initiated a new physical training program which emphasizes the development and maintenance of cardiovascular fitness through aerobic training for personnel 40 years of age and older. Personnel in this age group are almost exclusively senior staff personnel who often do not have the opportunity to train on a scheduled basis with a unit thus necessitating a program which depends on their own initiative. The purpose of the present study was to determine the aerobic fitness profile of a representative sample of over 40 aged personnel in the Army and to evaluate the

efficacy of a self-administered, unsupervised program in enhancing cardiovascular fitness in this age group.

## Materials and Methods

Subjects participating in this study were 295 40 and over aged male personnel (age range 40-53) who were available for the entire study and who volunteered to participate from approximately 600 individuals identified in this age group at a US Army post. The sample consisted of 173 enlisted and 122 officer personnel who comprised a cross-section of occupations, i.e., medical, administrative, unit commanders, etc., common to a typical military installation. All individuals were initially screened to preclude the presence of any cardiovascular disease prior to participating in the physical training program. This assessment included a resting 12-lead electrocardiogram, resting blood pressure determination, blood lipid profile to include cholesterol, triglyceride and high density lipoprotein (HDL) determinations, fasting blood sugar, complete medical history providing pertinent information on past medical problems and familial traits, smoking history, history of medication and drug use, and a comprehensive physical examination performed by a physician to assess cardiovascular signs and symptoms. In addition, all subjects underwent a physician-supervised, multistage, symptom-limited exercise tolerance test using the US Air Force School of Aerospace Medicine (USAFSAM) treadmill protocol (35). The American Heart Association standards (9) were followed during the performance of this test. Three-channel electrocardiographs (Quinton Model 630-A) with three-channel CRT monitors were used for continuous ECG monitoring during and after each exercise tolerance test. Baseline 12-lead ECG's and ECG tracings were recorded at each stage of exercise, immediately after exercise and for up to 10 min post exercise. Individuals with abnormal treadmill results and those with normal treadmill findings but who had abnormal cardiac findings or high risk factor analysis were excluded from the training program.

Two-hundred seventy-six of the 295 subjects screened were cleared to take part in the Army's new self-administered, individualized, physical training program for 40 and over aged personnel (Army Field Manual 21-20 Physical Readiness Training. Final Draft. Sect. IV pg 3-1 thru 3-10, 1980. Headquarters, Department of the Army). The goal of this program is for individuals to achieve sufficient aerobic fitness during a six month training period to meet an age-adjusted standard for the two-mile run. The program consists of a progressive walk/run mode of exercise. Subjects enter the program, depending upon their initial level of physical activity, at one of three phases (preparatory, conditioning, maintenance) each of which consists of a progressive scale as to the duration and frequency of exercise. Sedentary individuals enter the program in the preparatory phase while those who have been exercising enter either the conditioning or maintenance phase at an appropriate level. The intensity of training is designed to achieve 70-85% of an individual's age-adjusted maximal heart rate.

Each subject was given a written description of the training program and provided guidance in choosing and implementing a regimen to fit his particular needs. This guidance was based on the principles of exercise prescription as established by the American Heart Association (10 ) and the American College of Sports Medicine (1). Subjects were also instructed to maintain a log of each exercise period which was periodically checked to assess progress.

A personal physical activity history was taken on each individual before and after the 6 months of training. Prior to training subjects were divided into three groups according to their level of physical activity for the purpose of data analysis: inactive, runs zero to 3 mi/wk; moderately active, runs at least 3 but less than 10 mi/wk; and, active, runs more than 10 mi/wk.

For a variety of reasons, e.g., retirements, medical profiles, temporary duty assignments, only 165 of the 276 subjects originally cleared were available for re-testing at the completion of the training period. The efficacy of the training program was determined by measuring maximal oxygen uptake ($\dot{V}O_2max$) before and after training in conjunction with the exercise tolerance test. The USAFSAM protocol is a modified Balke procedure where the treadmill is set at a fixed speed of 90 m/min at 0% grade. With the speed kept constant, the grade is raised 5% every 3 min without interruption until the subject is unable to continue due to fatigue or exhaustion. At each incremented stage in exercise intensity oxygen uptake was measured and the highest value achieved was taken as the maximal value.

Expired air was collected with the subject breathing through a mouthpiece attached to a low resistance Koegel valve and into Douglas bags during the third minute of each 3-min increment in intensity. An aliquot of expired air was analyzed with an Applied Electrochemistry S-3A oxygen analyzer and a Beckman LB-2 carbon dioxide analyzer. Expired air volumes were measured with a Collins chain-compensated gasometer.

Body weight (kg) and height (cm) were measured and skinfold thickness (mm) determined at the subscapular, triceps, biceps, and suprailiac sites using Harpenden calipers. Age-adjusted regression equations were used to estimate percent body fat (18).

A one-way analyses of variance for repeated measures was used to determine significant differences resulting from the training program.

## Results

The mean data and ranges for age, anthropometric measures and the maximal physiological responses to exercise are given in Table 1. A wide range of values is evident for all variables. A mean $\dot{V}O_2$ max of 38.1 $\pm$ 6.2 ml/kg • min (range 25.3 to 61.1 ml/kg • min) represents a large variation in cardiovascular fitness for the population studied. It is felt, therefore, that this range in fitness and the nature of the subject selection resulted in a sample that is reasonably representative of 40 and over aged personnel in the Army.

The relation of age to $\dot{V}O_2$ max and % BF is shown in Table 2 where the subjects are divided into seven age groups. The mean $\dot{V}O_2$ max for the youngest group (40 41 years of age) was 39.7 $\pm$ 6.6 ml/kg • min compared to the oldest (52-53 yrs of age) which was 36.8 ml/kg • min. This represents a 7% decline in aerobic power over an age span of 14 years. Percent body fat tended to be higher in the older age groups but the data were not as consistent across the age range as was seen for $\dot{V}O_2$ max .

In Table 3 values of $\dot{V}O_2$ max are presented from previous studies on healthy males between 40 and 55 years of age. As a result of differences in previous physical activity among the samples and in the techniques used to elicit $\dot{V}O_2$ max (treadmill vs cycle ergometer), the results are not directly comparable. However, it can be generally stated that a typical $\dot{V}O_2$ max for this age group is between 30 and 40 ml/kg • min.

Table 4 presents the mean anthropometric and maximal physiological data for subjects divided into three groups based on their level of physical activity as assessed by interview prior to participation in this study. These three groups, with the number of subjects shown in parentheses, were as follows: inactive (140), runs zero to 3 mi/wk; moderately active (53), runs more than 3 but less

than 10 mi/wk; and active (55), runs 10 mi or more per wk. Twelve individuals indicated that they participated in other activities, i.e., swimming, racquetball, tennis, etc., but they were not included in the activity estimation. No differences were seen in body weight or % BF among the three groups. $\dot{V}O_2$ max of the active group was 17% and 16% higher ($p \leq .01$) compared to the inactive group on an absolute (l/min) and relative (ml/kg • min) basis, respectively. The moderately active group also showed a significantly higher $\dot{V}O_2$ max ($p < .01$) compared to the inactive group. The interview procedure used to establish physical activity habits in these subjects was effective, therefore, in separating individuals into three levels of aerobic fitness.

Data on body composition and maximal responses to exercise determined before and after the 6-months prescribed training program are depicted for the three groups in Table 5. Of the 140 individuals who were initially classified as being inactive, only 78 (56%) were available for retesting. Thirty-four of these subjects indicated during a post-training interview that they had not participated to any significant degree in the program; forty-four subjects indicated that they participated to an extent that would be expected to produce a significant increase in $\dot{V}O_2$ max. There were no changes in body weight or % BF in either of these subgroups upon retesting after 6 months. In terms of $\dot{V}O_2$ max, only a slight and insignificant increase (4.4%) was seen in those subjects who indicated they had participated in the program. For the moderately active and active groups, 76% (39 of 53) and 80% (44 of 55) of the subjects were retested, respectively. Neither of these groups showed any changes in aerobic power or body composition during the 6-months training period.

## Discussion

This study represents perhaps the largest assessment of aerobic power using a direct measurement of $\dot{V}O_2$ max that has been performed in a 40 and over aged population. Since selection bias was minimized, the data is believed to reflect typical levels of cardiorespiratory fitness in Army personnel 40 years of age and above.

There are few studies on military populations to which the present results can be compared. Valid comparisons can only be made provided differences in testing methods are taken into account. In a select group of 56 US Military Academy faculty and staff over 35 yrs of age, Kowal et al (17) reported a $\dot{V}O_2$ max, using a treadmill protocol, of 41.4 and 50.6 ml/kg • min for a low activity and a high activity group, respectively. Froelicher et al. (12) also using the treadmill found an average $\dot{V}O_2$ max of 34.0 ml/kg • min for USAF aircrewmen of comparable age to those in the present study. In a large survey of Canadian forces personnel between the ages of 40-55 yrs, Myles and Allen (21) reported a mean value of 32.4 ml/kg • min using a submaximal predictive cycle ergometer test. If these latter data are corrected upwards by 15% for differences between cycle ergometer and treadmill as suggested by Shepard (30), then the results compare quite closely to those reported herein. Results of studies in over-40 aged civilian groups (TABLE 3) suggest that the Army personnel are not significantly different from their civilian counterparts in aerobic fitness. This may not be surprising since people in the Army work in occupations not dissimilar to those found in the civilian sector of our society. Furthermore, these data suggest that the Army, as represented by this sample, has placed no increased emphasis on training and fitness than the civilian sector, despite the fact that the military has the potential for mobilization which would require a high level of fitness for the unfit or overweight staff officer or noncommissioned officer.

A decline in $\dot{V}O_2$ max with age has been shown by a number of investigators (2,7,14,20). Recently, Heath et al. (16) concluded that the weight of evidence suggests that $\dot{V}O_2$ max decreases approximately 9% per decade in healthy men. While a major component of this decrease is undoubtedly a consequence of the aging process itself (13), other factors such as a decrease in physical activity, and an increase in body weight also contribute significantly to the decline. While it is difficult to make meaningful comparisons among studies due to differences in health status, natural endowment, and an individuals habitual level of exercise, it would appear that the decline in $\dot{V}O_2$ max with age seen in the present study was less than reported previously (16). For the decade 40-49, $\dot{V}O_2$ max declined only 6%.

A large body of data has accumulated over the past few years concerning the effects of physical training on $\dot{V}O_2$ max (1,26). These studies have shown that the improvement in $\dot{V}O_2$ max is directly related to frequency, intensity, and duration of training. Depending upon the quantity and quality of training, improvement in $\dot{V}O_2$ max ranges from 5% to 25%. While changes in $\dot{V}O_2$ max greater than 25% have been reported, they are usually associated with large total body mass and fat weight loss, or a low initial level of fitness. Age in itself does not appear to be a deterrent to endurance training. Recent studies in subjects ranging from 20 to 63 yrs of age have shown that the relative change in $\dot{V}O_2$ max with training in middle-aged and older men is similar to that seen in younger age groups (27,29,34). Although further investigation is necessary concerning the rate of improvement in $\dot{V}O_2$ max with age, at present it appears that older individuals need longer periods of time to adapt to training (1). Middle-aged sedentary subjects may take several weeks to adjust to the initial effects of training, and thus need a longer period to get the full benefit from a program. Thus, based upon available data, training programs of 16 to 20 weeks

have been suggested as being a good minimum standard to achieve improved aerobic fitness (26).

Based on this information, therefore, an increase in $\dot{V}O_2$ max in the range of 10-15% could have been expected for those subjects who took part in this 6-month program. The results, however, were disappointing from two aspects. First, a large number of subjects (44%) who were initially designated as inactive and who were retested at the end of 6 months did not participate in the program, and secondly, those individuals who were also originally inactive but did participate failed to show a significant improvement in $\dot{V}O_2$ max. The 4.4% increase seen in this latter subgroup represents a minimal change which barely exceeds the test-retest repeatability for the determination of $\dot{V}O_2$ max. This suggests that these subjects did not train at an appropriate intensity, duration, and frequency necessary to stimulate the cardiorespiratory system.

While it is difficult to establish an accurate "drop-out" rate since many subjects were unavailable for interview at the completion of the study, the percentage of nonparticipants in the inactive group is similar to data from other studies on noncompliance. Oldridge (23), in reviewing a series of studies on the compliance of apparently healthy male subjects, all of whom were volunteers, found an overall compliance of approximately 55% in training programs averaging 12 months. In programs of 6 months duration, Mann et al (18) and Massie and Shepard (19) reported compliances of 59% and 52%, respectively. Characterization of the noncomplier is of obvious importance to long-term prospective therapy for coronary artery disease. However, little information on such characteristics of the healthy noncomplier is available. In one study, Massie & Shepard (19) found noncompliers to be overweight and smokers suggesting that the individual who is not prepared to make such health behavior

changes as losing weight and ceasing to smoke is also likely to be a noncomplier. Such a generalization, however, could not be made in the present study as the nonparticipants did not differ in body weight or % BF from those who did participate.

Appreciating the need for increased physical activity and translating this need into action are, unfortunately, unrelated events. While the Army recognizes the need for improved aerobic fitness in its 40 and over aged members, the results of this study suggest that the approach evaluated here to accomplish this end was not satisfactory. According to Wilmore (33), any successful exercise program must accomplish two major goals: (1) teach the participants why they should become physically active, and (2) motivate them to follow through with a training program. Many existing programs fail because they do not adequately educate individuals in the benefits that may result from physical exercise. In addition to education, a person's adherence to an exercise program depends almost entirely on his motivation which may be provided in the form of external goals and rewards (32).

It was encouraging to find that approximately 46% of the subjects initially tested indicated that they participated in their own personal training program. These subjects, who comprised the moderately active and active groups, had a $\dot{V}O_2$ max that can be considered good to excellent for their age (3,30) which was maintained during the 6 month program. It is obvious, however, that much research is needed in the areas of education and motivation with emphasis on the unique problems of the military to find ways for those less fit to comply with self-administered training programs. In the military, the active life and the unit approach to physical training of the young infantry soldier provide him with a basis and a means for maintaining a high level of fitness. In the 40 and over aged soldier, the absence of an obvious occupation-related requirement for physical

fitness and the lack of a structured physical training program necessitate that participation in physical activity be left to individual initiative. The results of this study show, however, that merely providing subjects with a written program for the development of aerobic fitness is unsatisfactory. This suggests, therefore, that to improve participation in physical training in the Army will require an increased emphasis on supervision of the program and to positively reinforce individuals to maintain motivation and interest.

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TABLE 1. Age, anthropometric measures and maximal physiological responses to exercise prior to training (n = 276).

| | Mean $\pm$ SD | Range |
|---|---|---|
| Age (yrs) | 43.8 $\pm$ 3.0 | 40 - 53 |
| Height (cm) | 178.9 $\pm$ 6.7 | 155 - 196 |
| Weight (kg) | 83.7 $\pm$ 11.4 | 56.6 - 115.7 |
| Body Fat (%) | 26.0 $\pm$ 4.6 | 11.6 - 36.5 |
| Lean Body Mass (kg) | 61.6 $\pm$ 6.8 | 46.9 - 83.5 |
| $\dot{V}O_2$ max (l/min) | 3.16 $\pm$ 0.52 | 1.71 - 4.58 |
| $\dot{V}O_2$ max (ml/kg min) | 38.1 $\pm$ 6.2 | 25.3 - 61.1 |
| HR max (BPM) | 181.6 $\pm$ 9.2 | 157 - 203 |
| $\dot{V}_E$ max (l/min BTPS) | 123.1 $\pm$ 23.8 | 60.8 - 219.4 |
| Max TM Time (min) | 15.3 $\pm$ 2.9 | 6 - 24 |

*TM = Treadmill

TABLE 2. Effect of age on percent body fat and maximal aerobic power (mean $\pm$ SD).

| Age | n | % Body Fat | $\dot{V}O_2$ max (ml/kg • min) |
|---|---|---|---|
| 40 - 41 | 71 | 25.0 $\pm$ 5.0 | 39.7 $\pm$ 6.6 |
| 42 - 43 | 77 | 26.6 $\pm$ 4.5 | 38.1 $\pm$ 5.9 |
| 44 - 45 | 55 | 26.9 $\pm$ 4.3 | 37.6 $\pm$ 6.0 |
| 46 - 47 | 38 | 26.2 $\pm$ 4.0 | 37.2 $\pm$ 6.6 |
| 48 - 49 | 21 | 23.8 $\pm$ 5.9 | 37.2 $\pm$ 5.1 |
| 50 - 51 | 10 | 26.5 $\pm$ 3.4 | 36.6 $\pm$ 5.1 |
| 52 - 53 | 4 | 29.6 $\pm$ 4.5 | 36.8 $\pm$ 9.8 |

TABLE 3. Comparison of $\dot{V}O_2$ max data from present study with other studies of 40-55 year-old males.

| Investigator | Age (yr) | n | Testing Mode* | $\dot{V}O_2$ max (ml/kg • min) |
|---|---|---|---|---|
| Ribisl (28) | 40.2 | 15 | CE | 40.1 |
| Saltin et al. (29) | 40.5 | 42 | CE | 37.5 |
| Wilmore et al. (34) | 40.5 | 16 | CE | 40.1 |
| Naughton & Nagle (22) | 41.0 | 18 | CE | 31.3 |
| Hanson et al. (15) | 48.9 | 7 | CE | 35.8 |
| Pollock et al. (27) | 48.9 | 15 | TM | 29.9 |
| Froelicher et al. (12) | 40 - 44 | 59 | TM | 34.0 |
| | 45 - 49 | 68 | TM | 33.5 |
| | 50 - 53 | 19 | TM | 34.0 |
| Cumming et al. (5) | 40 - 45 | 22 | CE | 31.9 |
| | 46 - 49 | 14 | CE | 30.4 |
| | 50 - 55 | 22 | CE | 30.0 |
| Present Study | 40 - 53 | 260 | TM | 38.1 |

*CE = Cycle Ergometer; TM = Treadmill

TABLE 4. Anthropometric and maximal physiological data for subjects grouped by physical activity history prior to training (Mean ± SD).

| | Activity Group | | |
|---|---|---|---|
| | Inactive n = 140 | Moderately Active n = 53 | Active n = 55 |
| Age (yrs) | 43.9 ± 3.1 | 43.5 ± 2.6 | 43.6 ± 3.1 |
| Ht (cm) | 178.0 ± 6.6 | 179.7 ± 6.9 | 179.6 ± 6.9 |
| Wt (kg) | 83.9 ± 12.8 | 83.2 ± 10.0 | 84.4 + 11.0 |
| % Body Fat | 26.1 ± 4.7 | 25.9 ± 4.9 | 26.1 ± 4.1 |
| $\dot{V}O_2$ max (l/min) | 2.99 ± $0.46^{a,b}$ | 3.31 ± 0.52 | 3.49 ± 0.49 |
| $\dot{V}O_2$ max (ml/kg • min) | 36.1 ± $5.3^{a,b}$ | 39.8 ± 5.4 | 41.9 ± 6.7 |
| HR max | 182 ± $10^{b}$ | 183 ± 9 | 178 ± 7 |
| $\dot{V}_E$ max (l/min BTPS) | 120 ± $23^{b}$ | 125 ± 24 | 131 ± 24 |
| Max TM Time (min) | 14.6 ± $2.7^{a,b}$ | 16.0 ± 2.7 | 16.8 ± 2.7 |

a = significantly different from moderately active group;

b = significantly different from active group. $p < .01$ ANOVA

TABLE 5. Anthropometric and maximal physiological data by activity group before and after 6-months training (mean ± SD).

| | | Activity Group | | | |
|---|---|---|---|---|---|
| | | Inactive | | Moderately Active | Active |
| | | Nonparticipants | Participants | | |
| | | (N = 34) | (N = 44) | (N = 39) | (N = 44) |
| Weight (kg) | Pre-T* | 84.0 ± 11.5 | 83.8 ± 11.8 | 84.6 ± 10.6 | 82.8 ± 11.1 |
| | Post-T | 83.4 ± 10.3 | 83.1 ± 10.9 | 84.5 ± 9.5 | 82.5 ± 10.2 |
| % Body Fat | Pre-T | 24.9 ± 5.6 | 26.2 ± 4.4 | 25.8 ± 4.9 | 25.7 ± 4.4 |
| | Post-T | 25.2 ± 5.0 | 26.7 ± 4.1 | 26.0 ± 4.3 | 26.0 ± 4.2 |
| $\dot{V}O_2$ max(ml/kg•min) | Pre-T | 35.9 ± 4.3 | 36.4 ± 5.5 | 40.3 ± 5.9 | 42.6 ± 6.7 |
| | Post-T | 36.3 ± 4.3 | 38.0 ± 5.4 | 39.8 ± 4.5 | 42.7 ± 6.3 |
| HRmax (BPM) | Pre-T | 179 ± 10 | 183 ± 11 | 183 ± 9 | 179 ± 7 |
| | Post-T | 178 ± 12 | 181 ± 9 | 180 ± 11 | 178 ± 9 |
| $\dot{V}_E$ max (l/min BTPS) | Pre-T | 125 ± 25 | 117 ± 22 | 128 ± 24 | 131 ± 26 |
| | Post-T | 127 ± 27 | 121 ± 24 | 130 ± 24 | 133 ± 28 |

*Pre-T = pre-training; Post-T = post training

Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research.